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Chen et al.

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(54) **TANDEM COMPRESSOR SYSTEM AND METHOD**

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(22) Filed: **Jun. 16, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**
F04B 41/06 (2006.01)

(52) **U.S. Cl.** **417/3**; 417/312; 62/510

(58) **Field of Classification Search** 417/2, 3, 417/312; 62/470, 510
See application file for complete search history.

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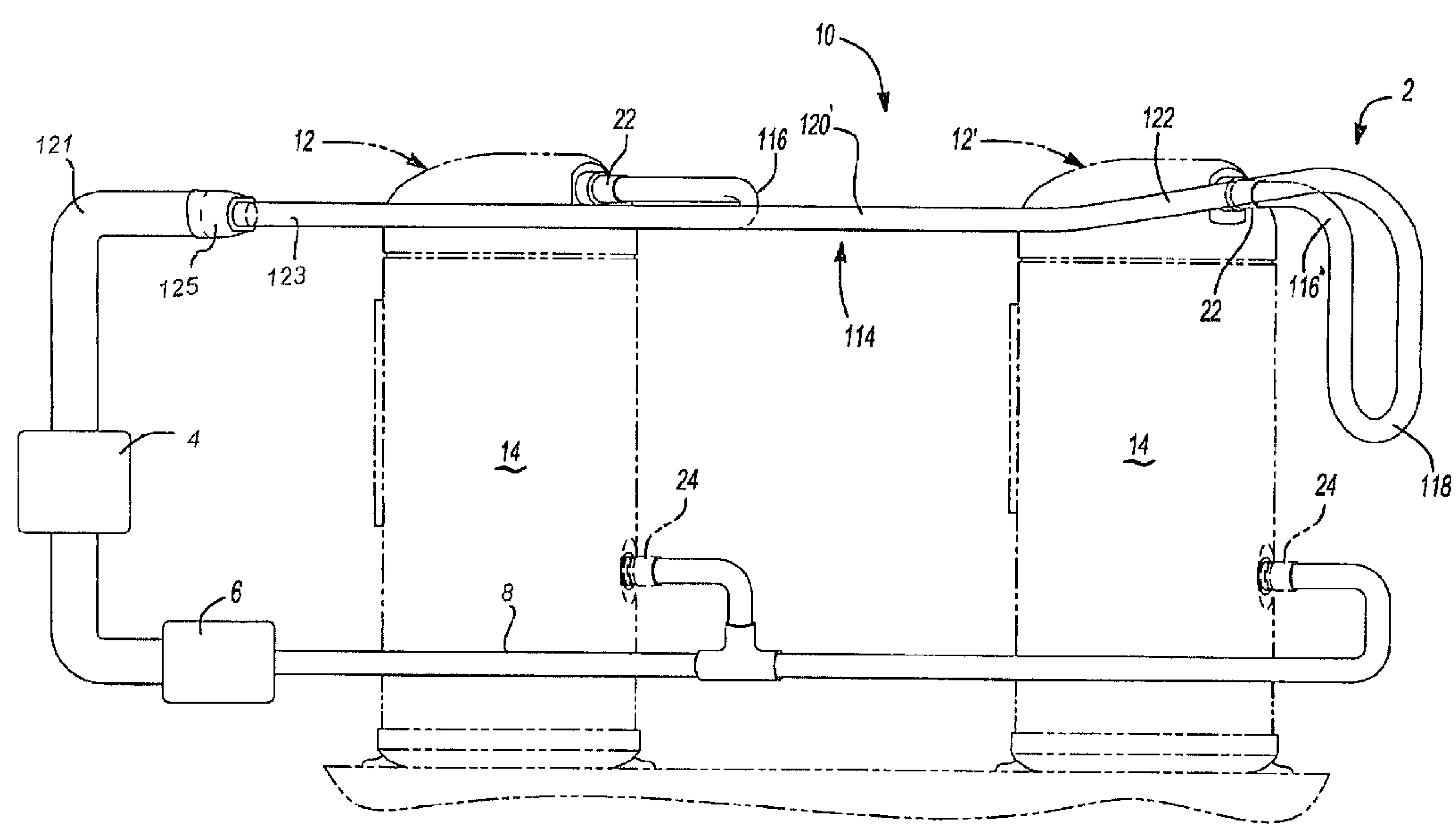
(57) **ABSTRACT**

A compressor system including a first compressor and a second compressor. The first and second compressors each include a shell, a compression mechanism disposed within the shell, and a drive member adapted to drive the compression mechanism. A discharge tube assembly interconnects the first compressor and the second compressor, and the discharge tube assembly includes an inlet portion adjacent the first compressor that is inclined relative to another inlet portion adjacent the second compressor. The inlet portion that is inclined is adapted to prevent a backflow of oil through the discharge tube assembly.

13 Claims, 4 Drawing Sheets



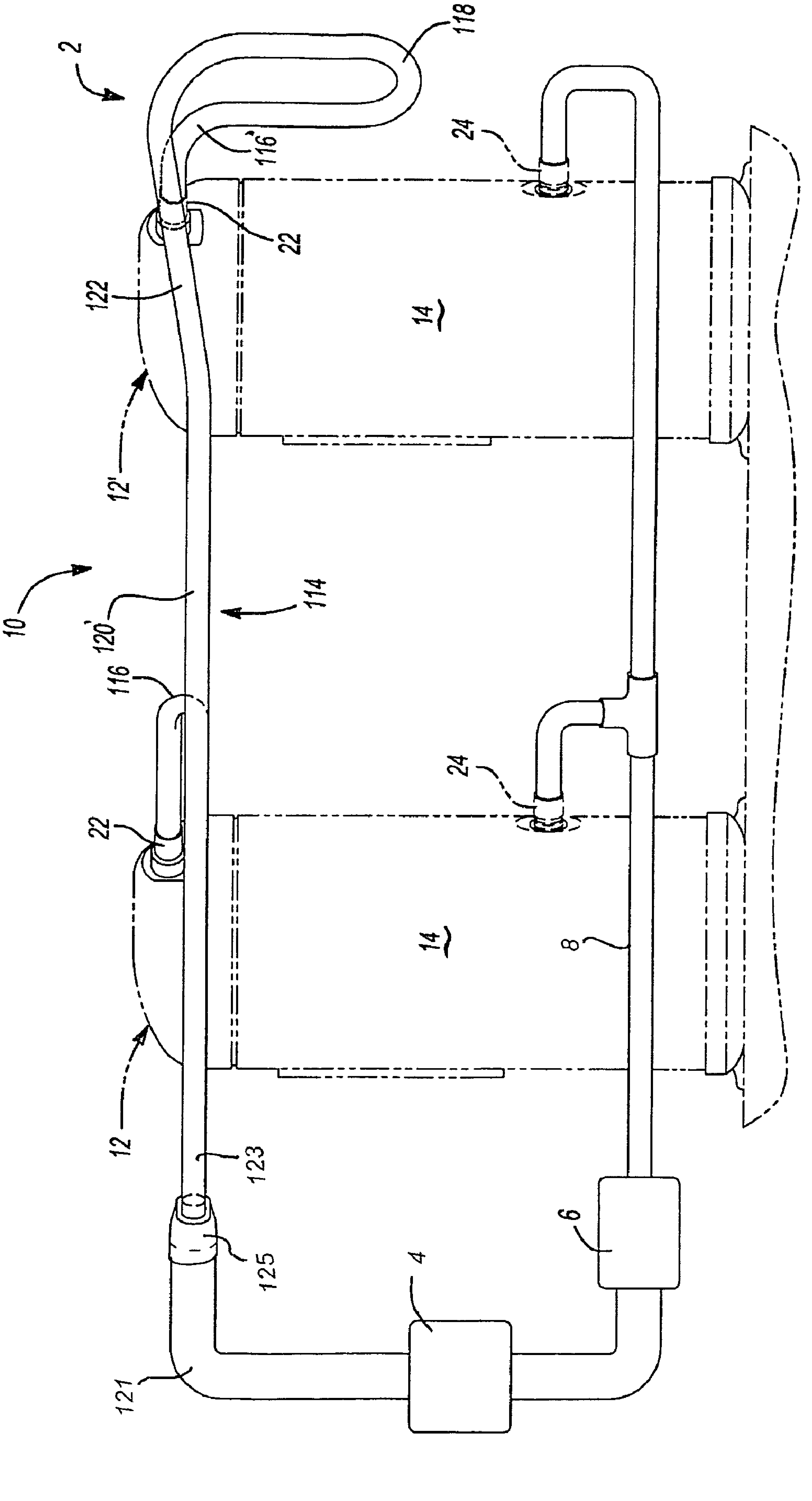


Fig-1

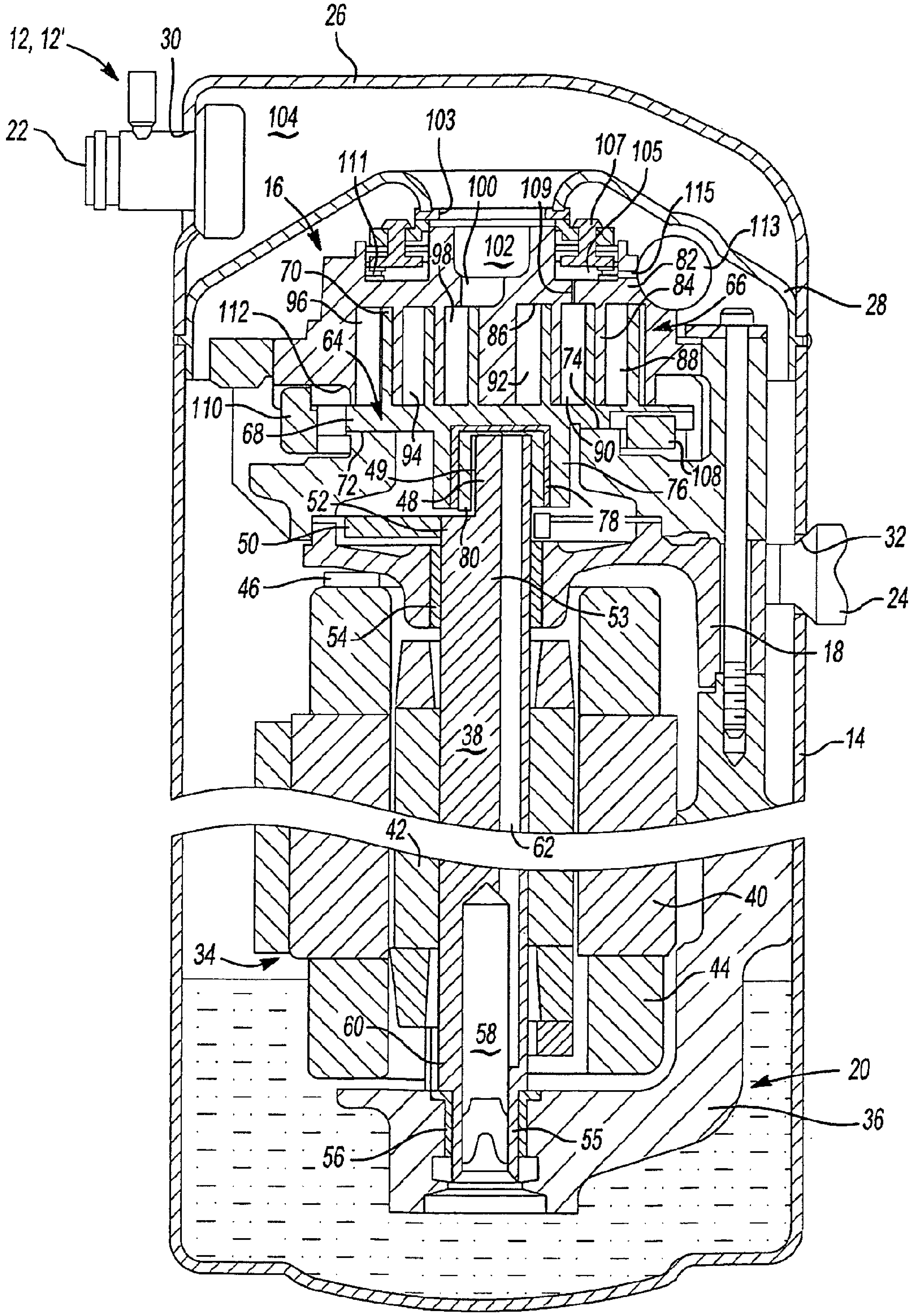

12, 12'
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Fig-2

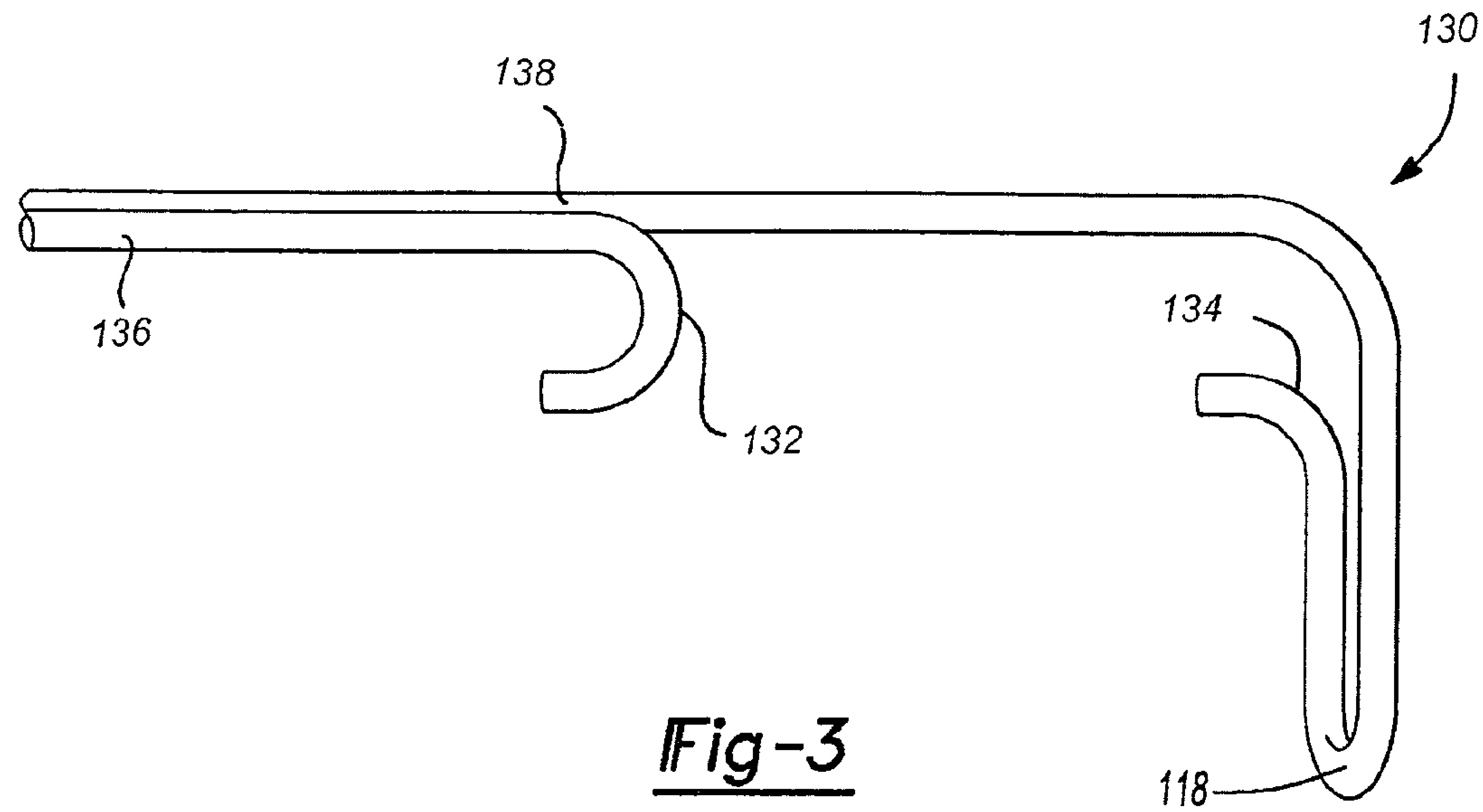

Fig-3
PRIOR ART

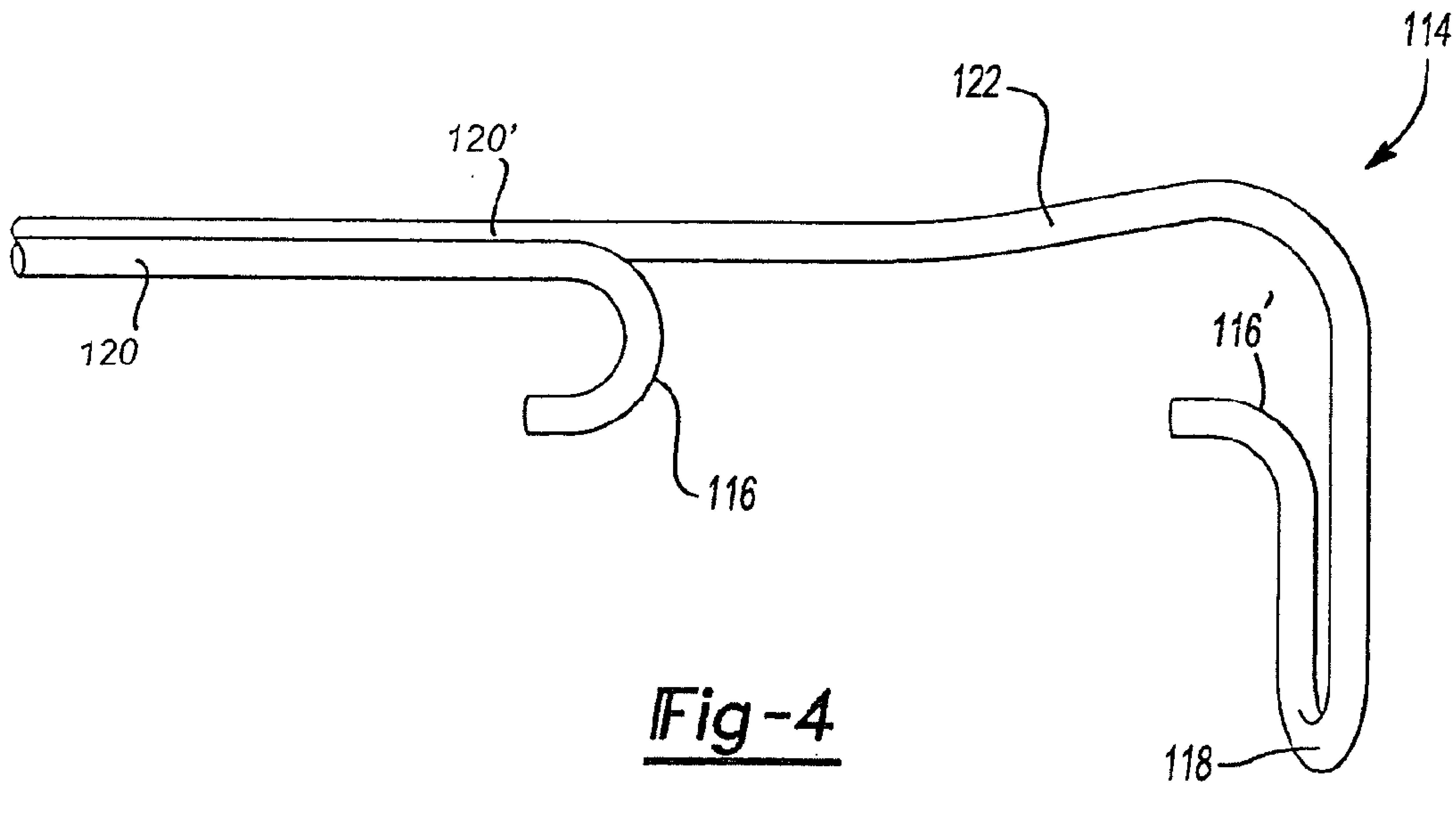

Fig-4

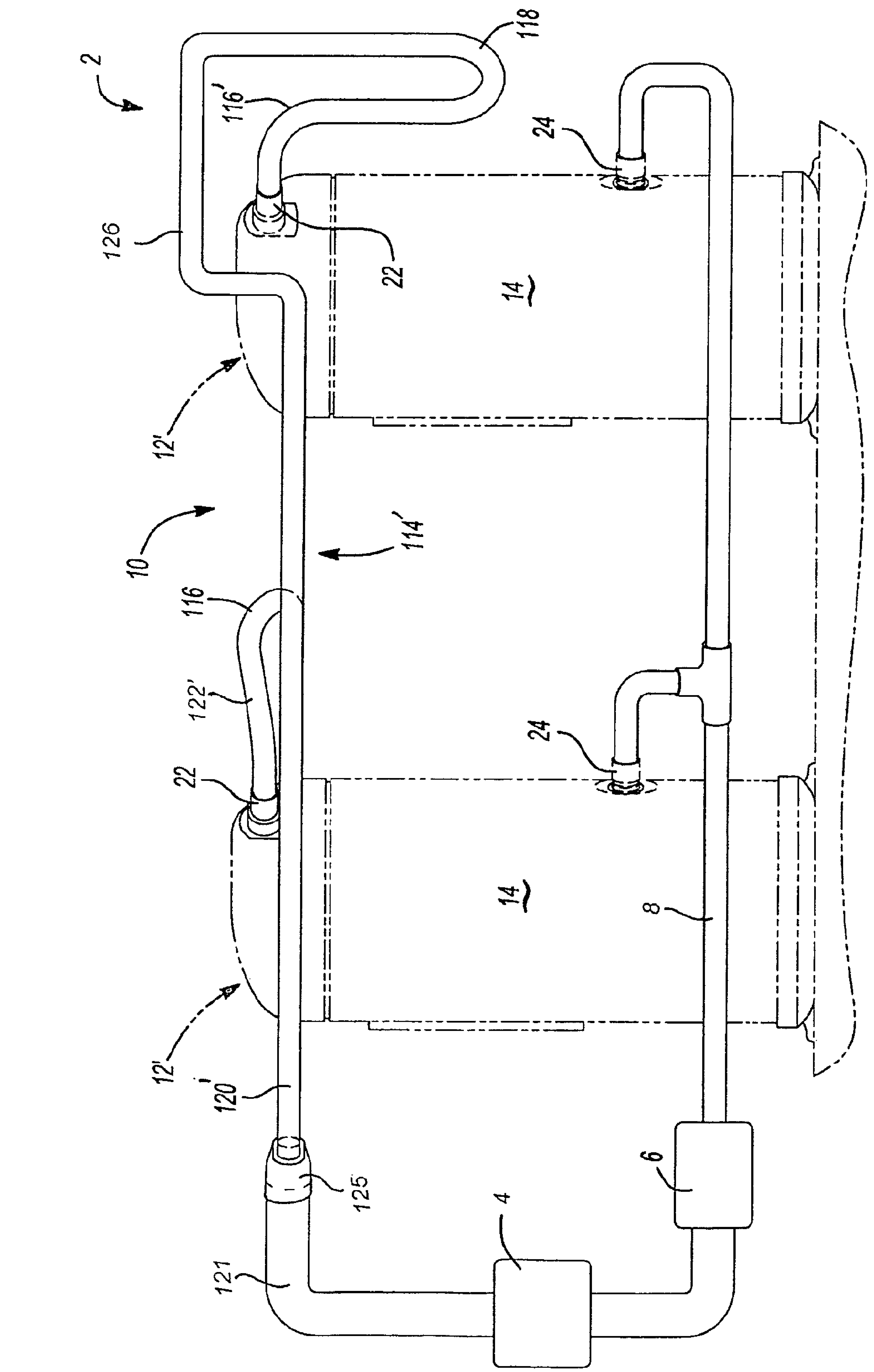

Fig-5

TANDEM COMPRESSOR SYSTEM AND METHOD

FIELD

The present disclosure relates to a tandem compressor system and method.

BACKGROUND

The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

A tandem compressor system consists of two compressors. A discharge tube assembly connects the two compressors to the outside system. When only a single compressor is running, oil may enter the discharge tube assembly and flow back toward the non-running compressor. The presence of oil in the discharge tube near the non-running compressor adds mass to the discharge tube assembly and reduces tube modal frequencies, which, in turn, may lead to tube resonance problems and tube failures.

SUMMARY

The present teachings provide a compressor system comprising a first compressor and a second compressor. The first and second compressors may each include a shell, a compression mechanism disposed within the shell, and a drive member adapted to drive the compression mechanism. A discharge tube assembly including a first discharge tube and a second discharge tube may interconnect the first compressor and the second compressor, and a distal portion of the first discharge tube and a distal portion of the second discharge tube may be joined at a common discharge tube. A proximate portion of the first discharge tube may be elevated relative the distal portion of the first discharge tube.

The proximate portion may include a shock loop.

The proximate portion may be elevated relative to the distal portion to prevent a backflow of oil through the discharge tube assembly.

The proximate portion may be angled relative to the distal portion between 5 degrees and 10 degrees.

The proximate portion may be angled relative to the distal portion between 1 degree and 90 degrees.

The proximate portion may be elevated relative to the distal portion by at least one half a tube diameter.

A proximate portion of the second discharge tube may be elevated relative the distal portion of the second discharge tube.

The present teachings also provide a compressor system comprising a first compressor and a second compressor. The first and second compressors may each include a shell, a compression mechanism disposed within the shell, a drive member adapted to drive the compression mechanism, a suction inlet fitting, and a discharge fitting. A discharge tube assembly may extend from the discharge fittings including a first discharge tube and a second discharge tube interconnecting the first compressor and the second compressor. A distal portion of the first discharge tube and a distal portion of the second discharge tube may be joined at a common discharge tube, and a proximate portion of the first discharge tube may be elevated relative the discharge fitting of the first compressor.

The proximate portion may prevent a backflow of oil through the discharge tube assembly.

The proximate portion may be upwardly angled relative the distal portion

The proximate portion may be upwardly angled relative the distal portion between 5 degrees and 10 degrees.

The proximate portion may be upwardly angled relative the distal portion between 1 degree and 90 degrees.

The proximate portion may be elevated relative to the discharge fitting by at least one half a tube diameter.

A proximate portion of the second discharge tube may be elevated relative the distal portion of the second discharge tube.

The present teachings also provide a compressor system comprising a first compressor and a second compressor. The first and second compressors may each include a shell, a compression mechanism disposed within the shell, and a drive member adapted to drive the compression mechanism. The compression mechanism may include a first scroll member having a first spiral wrap, and a second scroll member having a second spiral wrap intermeshed with the first spiral wrap of the first scroll member. A discharge tube assembly including a first discharge tube and a second discharge tube may interconnect the first compressor and the second compressor. Distal portions of the first and second discharge tubes may be joined at a common discharge tube, and proximate portions of the first and second discharge tubes may be elevated relative the distal portions.

The proximate portions may prevent a backflow of oil through the discharge tube assembly.

The proximate portions may be upwardly angled relative the distal portions between 5 degrees and 10 degrees.

The proximate portion of the first discharge tube may be upwardly angled relative the distal portion of the first discharge tube between 1 degree and 90 degrees.

The proximate portions may be elevated relative to the distal portions by at least one half a tube diameter of the first and second discharge tubes.

Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the claims.

DRAWINGS

The drawings described herein are for illustration purposes only and are not intended to limit the present disclosure.

FIG. **1** is a perspective view of a tandem compressor system including a discharge tube assembly according to the present teachings;

FIG. **2** is a cross-sectional view of an exemplary compressor used in the tandem compressor system;

FIG. **3** is a perspective view of a prior art discharge tube assembly;

FIG. **4** is a perspective view of a discharge tube assembly according to the present teachings; and

FIG. **5** is a perspective view of a tandem compressor system including a discharge tube assembly according to the present teachings.

DETAILED DESCRIPTION

The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

Referring to FIG. **1**, a compressor system **2** including a tandem compressor configuration **10** is shown. Compressor system **2** generally includes tandem configuration **10**, a condenser **4**, and an evaporator **6**. Tandem configuration **10** includes a pair of compressors **12** and **12'** that are adapted to operate either singularly or in combination. Each of compressors **12** and **12'** may be a scroll compressor, as illustrated in FIGS. **1** and **2**, or any other type of compressor known in the art. In this regard, the present teachings may be adapted to operate with any type of compressor known to one skilled in the art, including rotary, rotating, orbiting, and reciprocating types.

As shown in FIG. **2**, compressors **12** and **12'** may include a cylindrical hermetic shell **14**, a compression mechanism **16**, a main bearing housing **18**, a motor assembly **20**, a refrigerant discharge fitting **22**, and a suction gas inlet fitting **24**. Hermetic shell **14** may house compression mechanism **16**, main bearing housing **18**, and motor assembly **20**. Shell **14** may include an end cap **26** at an upper end thereof and a transversely extending partition **28**. Refrigerant discharge fitting **22** may be attached to shell **14** at an opening **30** in end cap **26**. Suction gas inlet fitting **24** may be attached to shell **14** at an opening **32**. Compression mechanism **16** may be driven by motor assembly **20** and supported by main bearing housing **18**. Main bearing housing **18** may be affixed to shell **14** at a plurality of points in any desirable manner.

Motor assembly **20** may generally include a motor **34**, a frame **36** and a drive member or drive shaft **38**. Motor **34** may include a motor stator **40** and a rotor **42**. Motor stator **40** may be press fit into frame **36**, which may in turn be press fit into shell **14**. Drive shaft **38** may be rotatably driven by stator **40**. Windings **44** may pass through stator **40**. Rotor **42** may be press fit on drive shaft **38**. A motor protector **46** may be provided in close proximity to windings **44** so that motor protector **46** will de-energize motor **34** if windings **44** exceed their normal temperature range.

Drive shaft **38** may include an eccentric crank pin **48** having a flat **49** thereon and one or more counter-weights **50** at an upper end **52**. Drive shaft **38** may include a first bearing portion **53** rotatably journaled in a first bearing **54** in main bearing housing **18** and a second bearing portion **55** rotatably journaled in a second bearing **56** in frame **36**. Drive shaft **38** may include an oil-pumping concentric bore **58** at a lower end **60**. Concentric bore **58** may communicate with a radially outwardly inclined and relatively smaller diameter bore **62** extending to the upper end **52** of drive shaft **38**. The lower interior portion of shell **14** may be filled with lubricating oil. Concentric bore **58** may provide pump action in conjunction with bore **62** to distribute lubricating fluid to various portions of compressor **12** and **12'**.

Compression mechanism **16** may generally include an orbiting scroll **64** and a non-orbiting scroll **66**. Orbiting scroll **64** may include an end plate **68** having a spiral vane or wrap **70** on the upper surface thereof and an annular flat thrust surface **72** on a lower surface. Thrust surface **72** may interface with an annular flat thrust bearing surface **74** on an upper surface of main bearing housing **18**. A cylindrical hub **76** may project downwardly from thrust surface **72** and may include a journal bearing **78** having a drive bushing **80** rotatively disposed therein. Drive bushing **80** may include an inner bore in which crank pin **48** is drivingly disposed. Crank pin flat **49** may drivingly engage a flat surface in a portion of the inner bore of drive bushing **80** to provide a radially compliant driving arrangement.

Non-orbiting scroll member **66** may include an end plate **82** having a non-orbiting spiral wrap **84** on lower surface **86** thereof. Non-orbiting spiral wrap **84** may form a meshing engagement with wrap **70** of orbiting scroll member **64**, thereby creating an inlet pocket **88**, intermediate pockets **90**, **92**, **94**, **96**, and outlet pocket **98**. Non-orbiting scroll **66** may have a centrally disposed discharge passageway **100** in communication with outlet pocket **98** and upwardly open recess **102** which may be in fluid communication via an opening **103** in partition **28** with a discharge muffler chamber **104** defined by end cap **26** and partition **28**.

Non-orbiting scroll member **66** has in the upper surface thereof an annular recess **105** having parallel coaxial side walls in which is sealingly disposed for relative axial movement an annular floating seal **107** which serves to isolate the bottom of recess **105** from the presence of gas under suction and discharge pressure so that it can be placed in fluid communication with a source of intermediate fluid pressure by means of a passageway **109**. A spring **111** may urge floating seal **107** upward to maintain a sealing engagement. Non-orbiting scroll member **66** is thus axially biased against orbiting scroll member **64** by the forces created by discharge pressure acting on the central portion of scroll member **66** and those created by intermediate fluid pressure acting on the bottom of recess **105**.

Compressor **12** and **12'** may use a dual pressure balancing scheme to axially balance non-orbiting scroll member **66** with floating seal **107** being used to separate the discharge gas pressure from the suction gas pressure.

A solenoid valve **113** may be used to open and close a passageway **115** located within non-orbiting scroll **66**. Passageway **115** extends from the bottom of recess **105** which is at intermediate pressure during operation of compressor **12** and **12'** to the area of compressor **12** and **12'** which contains suction gas at suction gas pressure.

Relative rotation of the scroll members **64** and **66** may be prevented by an Oldham coupling, which may generally include a ring **108** having a first pair of keys **110** (one of which is shown) slidably disposed in diametrically opposed slots **112** (one of which is shown) in non-orbiting scroll **66** and a second pair of keys (not shown) slidably disposed in diametrically opposed slots in orbiting scroll **64**.

As stated earlier it should be understood that although the above scroll compressor **12** and **12'** may be used for each compressor in the tandem compressor configuration **10**, any type of scroll compressor may be used for the compressors **12** and **12'** that is known to one skilled in the art. Moreover, although it is preferred that the same type of compressor be used for each compressor in tandem configuration **10**, it is not out of the scope of the present teachings to use different types of scroll compressors for each of the compressors. Also, although the compressors **12** and **12'** are shown to stand vertically in FIG. **1**, the present teachings should not be limited thereto. The compressors **12** and **12'**, rather, may also be horizontally oriented so long as the backflow of oil through a discharge tube assembly is prevented, as described below.

Compressors **12** and **12'** are connected by a refrigerant tube **8** that enables a refrigerant or fluid to pass between each of compressors **12** and **12'**. In this manner, compressors **12** and **12'**, when operating in tandem, may operate with an increased output capacity. In accordance with the present teaching, compressors **12** and **12'** also share a discharge tube assembly **114** that connects compressors **12** and **'12**, as well as connects compressors **12** and **12'** to refrigerant system **2** including condenser **4** and evaporator **6**. Discharge tube assembly **114** shared by the compressors **12** and **12'** is shown, for example, in FIG. **1**.

With particular reference to FIGS. **3** and **4**, discharge tube assembly **114** includes a pair of proximate portions **116** and **116'** that are connected to outlet fittings **22** of compressors **12** and 12'. Proximate portion 116' connected to compressor 12' may include a shock loop 118, which may be used to reduce stress in discharge tube assembly 114 during start/stop and running conditions by changing a stiffness of the discharge tube assembly 114 and its resonant frequencies. After shock loop 118, proximate portions 116 and 116' of compressors 12 and 12' connect to elongated tubes 120 and 120'. Elongated tubes 120 and 120' connect to a common discharge tube 121 at distal ends 123 thereof via a fitting 125 (FIG. 1). Common discharge tube 121 connects compressors 12 and 12' to the rest of compressor system 2, which includes condenser 4 and evaporator 6.

FIG. 3 shows a conventional discharge tube assembly 130 including a shock loop 118. As shown in FIG. 3, after shock loop 118, proximate portions 132 and 134 of compressors 12 and 12' each connect to elongated tubes 136 and 138 that are substantially straight and horizontal. When only compressor 12 of the tandem configuration 10 is running, oil may pass through the proximate portion 132, enter elongated tube 136, and subsequently enter common discharge tube 121. Because elongated tubes 136 and 138 are substantially straight and horizontal, the oil that has entered common discharge tube 121 may flow back towards and reenter elongated tubes 136 and 138. If oil enters elongated tube 138, oil may subsequently accumulate in shock loop 118 of proximate portion 134 adjacent compressor 12'. Any oil that accumulates in shock loop 118 may add unnecessary mass to discharge tube assembly 130 and may reduce the modal frequencies of discharge tube assembly 130. The reduced modal frequencies may lead to resonant problems of the discharge tube assembly 130, which in turn may lead to the assembly 130 failing. That is, discharge tube assembly 130 may break off from outlet fittings 22 of compressors 12 and 12'.

Discharge tube assembly 114 shown in FIG. 4 may be provided with an inclined portion 122, which prevents, or at least minimizes, any oil that may accumulate in elongated tube 120' from flowing into shock loop 118. Inclined portion 122 elevates proximate portion 116' relative to distal portion 123 of elongated tube 120' and discharge fitting 22, and requires any oil present in the elongated tube 120' to flow upwards through inclined portion 122 before it can reach shock loop 118. Due to gravity, the oil is prevented from flowing through inclined portion 122 into shock loop 118. Modal frequencies of discharge tube assembly 114, therefore, may be controlled and failure of discharge tube assembly 114 may be prevented.

Inclined portion 122 may be angled upward relative elongated tube 120' by an angle between 5 degrees and 10 degrees relative horizontal. Inclined portion 122 may be formed by bending discharge tube assembly 114 at a point adjacent shock loop 118, which may reduce manufacturing time and cost. Notwithstanding, any angle of inclination between about 1 degree and 90 degrees relative horizontal may be used.

Discharge tube assembly 114' in FIG. 5 has an inclined portion 126 inclined approximately 80 degrees to 90 degrees relative to horizontal tube 120'. Inclined portion 126 may also be elevated relative to horizontal tube 120' and discharge fitting 22 by a distance that may range between half a diameter of tube 120' and a diameter of tube 120'. In other words, the distance between inclined portion 126 and elongated tube 120' may range between a half diameter of tube 120' and a full diameter of tube 120'. Regardless, inclined portion 126 may be elevated relative to elongated tube 120' that is sufficient to prevent backflow of oil.

Furthermore, it should be understood that although the present teachings have been described relative to a discharge tube assembly 114 including shock loop 118, the present teachings should not be limited thereto. That is, discharge tube assembly 114 does not require use of shock loop 118 and may be formed to have an inclined portion 122 formed near proximate portion 116' of discharge tube assembly 114 adjacent outlet fitting 22 of the compressor 12'. Moreover, each compressor 12 and 12' may include a proximate portion 116 and 116' that includes an inclined portion 122 and 122' relative to horizontal tube 120.

The description of the present teachings is merely exemplary in nature and, thus, variations that do not depart from the gist of the present teachings are intended to be within the scope of the present teachings. Such variations are not to be regarded as a departure from the spirit and scope of the present teachings.

What is claimed is:

1. A compressor system comprising:

a first compressor and a second compressor, said first and second compressors each including a shell, a compression mechanism disposed within said shell, and a drive member adapted to drive said compression mechanism; and

a discharge tube assembly including a first discharge tube and a second discharge tube interconnecting said first compressor and said second compressor, a distal portion of said first discharge tube and a distal portion of said second discharge tube being joined at a common discharge tube, said first discharge tube including a shock loop, and an intermediate portion of said first discharge tube located between said shock loop and said distal portion of said first discharge tube being elevated relative said distal portion of said first discharge tube.

2. The compressor system of claim 1, wherein said intermediate portion being elevated relative to said distal portion prevents a backflow of oil through said first discharge tube to said shock loop.

3. The compressor system of claim 1, wherein said intermediate portion is angled relative to said distal portion between 5 degrees and 10 degrees.

4. The compressor of claim 1, wherein said intermediate portion is angled relative to said distal portion between 1 degree and 90 degrees.

5. The compressor system of claim 1, wherein said intermediate portion is elevated relative to said distal portion by at least one half a tube diameter.

6. The compressor of claim 1, wherein a proximate portion of said second discharge tube is elevated relative said distal portion of said second discharge tube.

7. A compressor system comprising:

a first compressor and a second compressor, said first and second compressors each including a shell, a compression mechanism disposed within said shell, a drive member adapted to drive said compression mechanism, a suction inlet fitting, and a discharge fitting; and

a discharge tube assembly extending from said discharge fittings including a first discharge tube and a second discharge tube interconnecting said first compressor and said second compressor, a distal portion of said first discharge tube and a distal portion of said second discharge tube being joined at a common discharge tube, said first discharge tube including a shock loop, and an intermediate portion of said first discharge tube located between said shock loop and said distal portion of said first discharge tube being elevated relative said discharge fitting of said first compressor.

8. The compressor system of claim **7**, wherein said intermediate portion prevents a backflow of oil through said first discharge tube to said shock loop.

9. The compressor system of claim **7**, wherein said intermediate portion is upwardly angled relative said distal portion of said first discharge tube.

10. The compressor system of claim **9**, wherein said intermediate portion is upwardly angled relative said distal portion of said first discharge tube between 5 degrees and 10 degrees.

11. The compressor system of claim **9**, wherein said intermediate portion is upwardly angled relative said distal portion of said first discharge tube between 1 degree and 90 degrees.

12. The compressor system of claim **7**, wherein said intermediate portion is elevated relative to said discharge fitting by at least one half a tube diameter.

13. The compressor of claim **7**, wherein a proximate portion of said second discharge tube is elevated relative said distal portion of said second discharge tube.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,118,563 B2
APPLICATION NO. : 12/139670
DATED : February 21, 2012
INVENTOR(S) : Jianxiong Chen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 2, Line 2	After “distal portion” insert --.--.
Column 4, Line 60	“'12” should be --12'--.

Signed and Sealed this
Twenty-sixth Day of June, 2012

David J. Kappos
Director of the United States Patent and Trademark Office